ASSIMILATING INNOVATIVE LEARNING/TEACHING APPROACHES INTO TEACHER EDUCATION - WHY IS IT SO DIFFICULT?

Atara Shriki

Ilana Lavy

Oranim Academic College of Education

Emek Yezreel Academic College

Research shows that most training programs aimed at qualifying pre-service teachers (PST) have a slight influence on their beliefs regarding learning and teaching. In order to understand the reasons of this phenomenon we asked our PST to write a portfolio while experiencing learning via a computerized-project-based-learning (CPBL) approach. Analysis of the PST's portfolio raised two main possible reasons for the stagnation of their beliefs: a lack of sufficient success in achieving expected goals, and an inadequate synchronization between the experience of innovative approaches and their implementation. In this paper we present a case study of one of our PST written reflections, in which those two issues are addressed.

INTRODUCTION

During the last two decades there have been intensive calls for implementing reforms in mathematics education (e.g., NCTM's standards, 2000). No doubt teachers should be the ones that put the innovative approaches into practice. Unfortunately real modifications are not as widespread as was expected. Various explanations can be suggested in order to clarify this phenomenon of "stagnation". One of the explanations might be related to what Desforges (1995) had found in his review of literature: teachers are not reflective; they are satisfied with their practices and do not tend to question educational processes. Moreover, they often disregard data that is inconsistent with their beliefs and practice and tend to avoid new experiences. Instead, they prefer to stick to only those practices that match their existing system of believes. Desforges (ibid) findings regarding the characteristics of in-service teachers raise two main questions: the first one concerns the underlying reasons of such behavior, and the second one relates to implication on teacher education. Since we mainly work with pre-service teachers (PST), we were curious about the latter question. It seems that the calls for reform disregard the difficulties experienced teachers might have while trying to adjust themselves to new settings. We were wondering whether experiencing innovative approaches while PST are in their process of training, constructing their pedagogical content knowledge, might raise their ability to adjust to innovative situations.

In this paper we describe our experience with PST of mathematics, in which we attempted to demonstrate the benefits of inquiry-based learning as an example of innovative approach. Though we succeeded in exhibiting some of the advantages of

that method, still we had to confront several obstacles. As follows we explain some of their sources and nature.

BACKGROUND

Our study examined difficulties PST had in adjusting to an inquiry-based environment aimed at introducing some innovative didactical approaches for teaching junior high-school mathematics. In this paper we discuss some of the PST's dilemmas that might be attributed to the need for creating a new system of beliefs, which is not consistent with the existed one. The theoretical framework of this paper focuses on the meaning of 'system of beliefs', and on social and sociomathematical norms, which are among the constituents of such a system.

System of beliefs. Beliefs are basic assumptions regarding perceptions and attitudes towards a certain reality. A System of beliefs does not require external approval (Tillema, 1998). The influence of beliefs is strongest on the meanings which people attribute to occurrences, and on activities they choose to carry out. PST hold beliefs regarding various aspects relating to teaching and learning, among them: their teaching role, students' learning processes, curriculum suitability, and so forth (Van-Dijk, 1998). Their beliefs reflect their values in terms of what is "desirable". As a result of thousands of hours in an "apprenticeship of observation", which inspire school students' perception regarding teaching and learning (Lortie, 1975), PST begin their training with explicit ideas regarding relevant issues (Tilema, 1995). For example, many PST believe that teachers supply knowledge to their students, and learning means memorizing the contents (Richardson, 1996). Their memories of themselves as learners influence their expectations of their future students as well as their views regarding "proper" teaching strategies. The image they possess regarding "good teaching" relates to the kind of teacher they see themselves becoming. As a consequence PST tend to exhibit conservative teaching, replicating their own teachers. Research (e.g. Kagan, 1992) suggests that PST's personal beliefs and images are not affected by their training practice and generally remain unchanged. They tend to utilize the information they are exposed to during their training mainly to strengthen their existing beliefs and perceptions. That means that the contents that are being presented in teacher education programs are subject to interpretations according to PST's pre-existing beliefs (Tillema, 1998). Those interpretations also affect their performance in class (Kagan, 1992), since they rely on their own subjective theories of teaching or on what they believe will work in class. Moreover, many PST expect their educators to tell them explicitly how to teach. Some expect to learn from their own experience. Others believe that teaching is an activity that every one can do and there is little need for training (Calderhead, 1992).

Social and sociomathemtical norms. Norms are among the constituents of system of beliefs. The theme of classroom norms has been largely discussed in recent years. Yackel and Cobb (1996) distinguished between general classroom social norms (for example: the need to explain or justify) and norms that are specific to students'

mathematical activities, termed as sociomathematical norms (for example: what counts as mathematically efficient, mathematically sophisticated, mathematically elegant, acceptable mathematical explanation and justification). The teacher's and the students' beliefs serve as key factors for negotiating classroom norms. The teacher-students verbal interactions provide the opportunity to negotiate the sociomathematical norms, which are continually regenerated and modified, and might differ substantially from one classroom to another.

METHODOLOGY

The research data included: (a) Transcripts of videotapes of all the class sessions; (b) Two written questionnaires; (c) Students' portfolios that included a detailed description of the various phases of the project and reflection on the process; (d) Informal interviews. During the class sessions the students raised their questions and doubts, asked for their classmates' advice, and presented their works.

Looking for phenomenological categories in the PST's portfolios, we applied inductive analysis (Goetz & Lecompte, 1984). We studied all the students' utterances through the lenses that concerned their perception regarding various issues relating to teaching and learning.

THE STUDY

The Context. In this paper we present a case study of one PST who participated in an annual course named "Didactical foundations of mathematics instruction". This course focuses on theories and didactical methods implemented in teaching and learning geometry and algebra in junior high-school. One of the main didactical methods discussed in this course is learning via Project-Based-Learning (PBL). PBL is a teaching and learning strategy that involves students in complex activities, and enables them to engage in exploring important and meaningful questions through a continuous process of investigation and collaboration. This process includes posing problems, asking questions, making predictions, designing investigations, collecting and analyzing data, sharing ideas, and so on (Krajcik, Czerniak and Berger, 1999). We termed the approach used in the current study as Computerized-Project-Based-Learning (CPBL) since it rested heavily on the use of computer software. Integrating computer software into the setting of PBL has many benefits. It enables the students to make a lot of experiments, observe stability/instability of phenomena, state and verify/refute conjectures easily and quickly, and so on (Marrades & Gutierrez, 2000).

The Subjects. 25 college students (8 male and 17 female students) in their third year of studying towards a B.A. degree in mathematics education participated in the research. The discussed course was the first didactical course they had taken.

In parallel the PST began their practice in school teaching. In the time they were working on the CPBL they mainly observed experienced teachers.

The CPBL*.* In order to clarify to the PST what we mean by CPBL and what its phases are, we exhibited a ready-made project which was based on Morgan's theorem (Watanabe, Hanson & Nowosielski, 1996). The PST had experienced CPBL, which included the following phases (Lavy & Shriki, 2003): (1) Solving a given geometrical problem, which served as a starting point for the project; (2) Using the "what if not?" strategy (Brown & Walters, 1990) for creating various new problem situations on the basis of the given problem; (3) Choosing one of the new problem situations and posing as many relevant questions as possible; (4) Concentrating on one of the posed questions and looking for suitable strategies in order to solve it; (5) Raising assumptions and verifying/refuting them; (6) Generalizing findings and drawing conclusions; (7) Repeating stages 3-6, up to the point in which the student decided that the project has been exhausted.

Experiencing the processes that are involved in CPBL enabled most of the PST to realize the benefits the learners gain from working on inquiry assignments (Lavy & Shriki, 2003). Among them: developing mathematical qualifications; increasing self-confidence in the mathematics competence; learning in an exiting and challenging environment. However, we had difficulties in trying to bring the PST to internalize the importance of integrating CPBL into their future classes. Through the reflective process of the PST we tried to find explanations to those difficulties. In this paper we bring parts of the reflection of one representative student. This student was chosen since her expressed beliefs were similar to those of the majority, yet she was more expressive then the others.

RESULTS AND DISCUSSION

In the following section we describe the case study of Ruth, who is a typical student from our class of PST. Ruth's reflection enables learning about the characteristics of the existing system of beliefs PST hold, and the characteristics of new generated beliefs that emerge within an environment that encourages inquiry activities.

Ruth's reflection shows that she experienced the process of learning in two modes in a sequential manner: first she experienced the learning processes as a student and then as a future teacher. In this section we relate to her system of beliefs, and use the abbreviations "eb" and "nb" for designating "existing belief" and "new belief", in accordance. We used "r_1"and "r_2" in order to designate the "repeat" of referring to a certain belief. In addition, we numbered each belief.

The Case of Ruth*.* Ruth is considered to be an average student; nevertheless her contribution to the class discussions was significant since she often tended to ask for further clarifications to issues that were raised by the students and the teacher. At the beginning of the process Ruth was motivated by her wish to discover a new mathematical regularity, and she kept on saying: "*I want to be like Morgan, I want to discover a new regularity*". At the initial phases of the project Ruth decided to focus on a problem situation in which she changed two of the original attributes. After a period of time, during which she kept on looking for regularities, she had managed to

find only marginal discoveries. As follows are some of her reflections during the various phases of her work.

By the end of the first class session in which we explained and demonstrated the components of a project, Ruth wrote:

At the beginning I asked myself whether there is any connection between what we ought to teach in school and what we have to do in this project. No one at school will ever let us teach in that manner **[eb1]**. Schools do not welcome such an approach **[eb2]**. So at the beginning I was not enthusiastic at all, until I heard about Morgan and his discovery. Only then I felt like I really want to do that - to explore and discover **[nb1]**.

Ruth began working on the project with great enthusiasm. After the second phase of the project she wrote:

After I wrote the list of various new problem situations I felt good as if I was going to discover something new in mathematics – I really love it! **[r$_1$nb1]**.

After the 4th phase Ruth reflected:

The work was very interesting and challenging **[nb2]**. At the beginning I felt a sense of anxiety, afraid I would choose to concentrate on an 'inappropriate' attribute, and it would be a waste of time **[eb3]**. But shortly after, when I worked with the software, I felt confident and it was clear to me that I will gain something meaningful from this project. I believe I will discover a new regularity **[r$_2$nb1]**.

During the 5th phase, after working without finding anything that seemed to her as a meaningful discovery, she wrote:

Sometimes during the work on the project I felt a lack of motivation. Perhaps it is because I am not used to activities of this kind **[eb4]**. During my school years we were asked to prove existing mathematical regularities **[eb5]**, and now we are asked to do something different, something that we are not used to – to discover something new. Since when do we have to choose the problem, to solve it and to investigate it? **[r$_2$nb1]**.

In her final reflection Ruth wrote:

…Contrarily to what I had said before I must say that when I observe and examine what I had gone through during the work on the project, I realize that only a minor part of the sessions contributed to my professional growth. As part of my educational duties I have to teach in various classes. I don't know yet how to teach and handle class situations in the traditional way [eb6], and you expect that I will adopt and implement innovative teaching approaches which I do not see their relevance to my work.

From the above excerpts it can be seen that Ruth holds beliefs regarding her current state as learner (nb1, nb2), her past experience as school student (eb3, eb4, eb5) and her role as a teacher (eb1,eb2,eb3,eb). Ruth's beliefs regarding herself as a future teacher are in fact a projection of her experience as a school student.

Ruth's beliefs regarding her state as a learner. At the beginning Ruth was enthusiastic. Influenced by the story about Morgan, she was eager to discover a new regularity [nb1]. The work with the interactive software, which facilitated the

examination of many problem situations, reinforced her self-confidence in her ability to discover a new regularity [$r_1$nb1]. She began to develop the belief that a discovery process is a challenging and interesting one [nb2]. As long as Ruth felt that she was able to progress in her work, she expressed a tendency towards adopting new beliefs concerning the essence of learning. However, Ruth's enthusiasm began to fade with time, as a result of unfulfilled self-expectations. When Ruth faced a situation in which she did not mange to discover any meaningful regularity she used her initial system of beliefs regarding learning in order to justify her failure [eb4,eb5]. In fact, she does not take responsibility for her lack of success. Instead of searching for new directions in the project, she retreated and used her existing system of beliefs as an "alibi" for her lack of success. Namely, she uses the fact that she is not familiar with this kind of learning, and the fact that it is not the way she believes school students should learn, as causes for not finding a new mathematical regularity. Her attachment to her existing system of beliefs points to the fact that she did not make any genuine links between this system and the new beliefs [nb1,nb2] she was beginning to consider enthusiastically in the initial stages.

Ruth's beliefs regarding her role as a teacher. Ruth started the project with a rigid system of beliefs concerning classroom norms that relate to teaching, learning and school functioning: schools have their own rules regarding "proper" teaching methods, and inquiry-based learning is not part of them (eb1, eb2); teachers should not invest time and efforts in methods that do not guarantee success or lead the student through "vague paths" (eb3), which are time consumers. The rules of the game in the mathematics class, the sociomathematics norms, are clear: teachers provide the problems and the students solve them (eb5).

Due to Ruth's limited experience as a teacher, it can be seen that her beliefs regarding teaching are based on what Lortie (1975) calls "thousands of hours in an "apprenticeship of observation". Indeed, Ruth's memories of herself as learner (Grossman, 1990) influence her willingness to open her mind to new teaching ideas, and in fact inhibit her professional growth. As long as Ruth experienced success she was demonstrating a tendency towards developing new beliefs. However, as can be seen from Ruth's reflection, she did so merely from the learner perspective. Namely, she did not consider any possible change in her beliefs regarding the teacher's role. Her disappointment caused her to examine the process from the teacher's perspective as well, using her existing system of beliefs. In the beginning of the process Ruth revealed her beliefs regarding school as a conservative organization (eb1, eb2). In the 4th and 5th phases she related to her beliefs (or sociomathematical norms) regarding her role as teacher (eb3,eb4,eb5) according to which the students should be led in a path that guarantees success or otherwise it is "a waste of time". In addition, the teachers should be the problems providers. Those problems ought to be already known theorems. The students' task is to find the correct proofs.

To summarize, Ruth's past experiences is dominant in determining her views and beliefs regarding learning and teaching. The experiences she gained during the

semester were subjected to interpretations in accordance with her already existing system of beliefs. Consequently, it seems that these experiences had slight influence, if any, on changing her beliefs. These findings are consistent with Kagan (1992).

CONCLUSIONS

Lamm (2000) had found that PST's systems of beliefs do not require external approval, and consequently many believe that teacher education programs have a slight influence, if any, on changing those beliefs. In our study we found reinforcement to Lamm's findings. Trying to comprehend the reasons that underlie this phenomenon, we used the analysis of the PST's portfolios. Through the PST's written reflections (with Ruth as a typical case) we managed to identify two main possible explanations:

Experiencing success as a motive for developing new beliefs. As long as Ruth was experiencing success she was willing to adjust her existing system of beliefs to the new learning situations. When Ruth felt that she was not fulfilling her self-expectations she "retreated" to her existing system of beliefs, and utilized them for justifying her failure. It can be assumed that experiencing success can serve as a motive for developing a new system of beliefs. However, a long period of time is needed in order to learn how to implement an inquiry activity and to be able to present a meaningful product. Thus, if teacher's educators wish to assure PST success, they should allow their students to experience this process, as well as other processes that concern innovative approaches, during the whole period of their training.

Choosing the proper timing for experiencing innovative approaches. In her final reflection, Ruth's excerpt eb6, points to the central role of choosing the right timing for introducing innovative approaches. As a "product" of the educational system, the PST had assimilated all the norms that are associated with this traditional organization. Moreover, during the period of their training they get their practical experience within that same system. Adopting innovative teaching/learning approaches requires the ability to adjust the existing system of beliefs to the desirable change. In order to do so, the PST must be convinced that this change is beneficial for them. The question is how to make them realize the necessity for change. Apparently, in order to reach a situation in which a change or an update of an existing system of beliefs regarding teaching and learning, will occurre, this system of beliefs has to be based on an extensive teaching experience and not on theoretical perceptions. It is reasonable to assume that PST would be able to recognize that the methods they are using are not satisfying only following a real practice, which will yield a conflict. Conflict is an essential psychological substance for considering new ideas. Therefore, it might be suggested that the exposure to innovative approaches will be gradual and continuant. PST should be instructed and guided how to implement innovative methods during their practical training. From our experience

experiencing innovative approaches in the framework of a didactical course without practicing it in class is to some extent insignificant.

References

Brown , S. I. & Walter, M. I. (1993). Problem Posing in Mathematics Education. In Stephen I. Brown & Marion I. Walter (Eds.) *Problem Posing: Reflection and Applications*, Hillsdale, New Jersey: Lawrence Erlbaum Associates. 16-27

Calderhead, J. (1992). The role of reflection in learning to teach, in I., Valli (Ed.), *Reflective teacher education: cases and critiques*, Albany: State University of New York Press, 139-146

Desforges C. (1995). How does experience affect theoretical knowledge for teaching?, *Learning and Instruction*, Vol. 5, Pp. 385-400

Goetz, J.P. and LeCompte, M.D.(1984). *Ethnography and Qualitative Design in Educational Research.* Academic Press.

Kagan, D. M. (1992). Professional growth among preservice and beginning teachers. *Review of Educational Research*. 62(2), 129-169

Krajcik, J., Czerniak, C. & Berger, C. (1999). *Teaching Children Science - A Project-Based Approach*, McGraw-Hill College, New York

Lavy I. & Shriki A. (2003). Pre-service teachers' transition from "knowing that" to "knowing why" via computerized project-based-learning, in N. A. Pateman, B. J. Dougherty, J. Zilliox (Eds.), *Proceedings of the 2003 joint meeting of PME and PMENA*, Pp. 3-181-3-188.

Lamm, Z. (2000). The ideology and the educational philosophy, in *Pressure and resistance in education: articles and conversation*, Tel Aviv: Sifriat Poalim (in Hebrew), 217-254

Lortie, D. C. (1975). *Schoolteacher*. Chicago: the University of Chicago Press

Marrades, R. & Gutierrez. A. (2000). Proofs produced by secondary school students learning geometry in a dynamic computer environment. *Educational Studies in Mathematics*, 44, 87-125.

NCTM - National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics.* Reston, VA: NCTM.

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), *Handbook of research on teacher education*, N.Y: Macmillan, 102-119

Tilema, H. H. (1995). Integrating knowledge and beliefs: promoting the relevance of educational knowledge for student teachers, in R. Hoz & M. Silberstein (Eds.), *Partnership of schools and institutions in higher education in teacher development*. Beer Sheva: Ben Gurion University of the Negev Press, 9-24

Tilema, H. H. (1998). Stability and change in student teachers' beliefs about teaching. *Teachers and Teaching: Theory and Practice*, 4(2), 217-228

Van-Dijk, T. A. (1998). *Ideology: A multidisciplinary approach*, London: Sage Publications

Watanabe T., Hanson R., & Nowosielski F. D. (1996). Morgan's Theorem. *The Mathematics Teacher*, 89 (5), 420-423

Yackel E. & Cobb P. (1996): Sociomathematical norms, argumentation, and autonomy in mathematics, *Journal for Research in Mathematics Education*, 27(4), 458-477.